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POPULATION BIOLOGY OF THE GREAT PURPLE HAIRSTREAK, *ATLIDES HALESUS*, IN TEXAS (LYCAENIDAE)

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ABSTRACT. The population biology of the great purple hairstreak, *Atlides halesus* Cramer, was studied at two sites in Texas. *A. halesus* feeds on mistletoe (*Phoradendron tomentosum* Engleman) and prefers the younger, non-woody parts of the plant. It is most common in late spring and prefers isolated host plants for oviposition at the southern site. Hymenopteran parasitoids are the major source of mortality, emerging from eggs, third instar larvae and pupae.

Atlides halesus Cramer is the largest widely distributed lycaenid butterfly in the United States. It ranges northward from Mexico to New York and Oregon, and is locally common in most of the southern states (Howe, 1975). Larvae feed on different species of mistletoe (*Phoradendron*, Loranthaceae). Haskin (1933) has described the life history of *A. halesus* in Florida. This article describes its population biology at two locales in Texas and includes information on time of development, phenology, response to host density, use of different plant parts and sources of mortality. American mistletoe (*Phoradendron tomentosum* Engl.) is the host of *A. halesus* in most parts of Texas. *P. tomentosum* is a widely distributed hemiparasitic shrub which infects a variety of deciduous trees. In central Texas, it is most common on ulmaceous hosts (*Ulmus crassifolia, Celtis* spp.), while further south it has apparently adapted to mesquite (*Prosopis glandulosa* Torrey, Leguminoseae).

METHODS

Two field sites were used, one for rearing caterpillars and the other for field observations. The Brackenridge Field Station of the University of Texas is located on the Colorado River, about two miles north of Town Lake in Austin, Texas. Elm (*Ulmus crassifolia*) and hackberry (*Celtis* spp.) are the major hosts of *P. tomentosum*. *A. halesus* is common in late spring, with adults sometimes found in groups of three or four on flowers. Adults are occasionally found flying in mid-winter in the Austin area. Three *A. halesus* larvae were collected at the Brackenridge Station and brought back to the lab for rearing, on 12 April 1979 (#1) and 16 April 1979 (#2, #3). The larvae were fed fresh *P. tomentosum* leaves and weighed daily on a CAHN Electrobalance until pupation.

The Chaparral Wildlife Management Area (CWMA) of the Texas

TABLE 1. Size classes of leaves and stems.

Size class	Stems (diameter) (mm)	Leaves (surface area/leaf) (mm^2)
1	Greater than 10	Greater than 500
2	5–10	300–500
3	2.5–5.0	100–300
4	0–2.5	0–100

Parks & Wildlife Department was used for field observations. The CWMA is about 60 miles north of the Mexican border at Laredo, with desert grassland vegetation dominated by mesquite (Whittaker et al., 1979). Mesquite is the only major host of *P. tomentosum*. Most of the mistletoe is on older trees found in disturbed areas. A total of 375 *P. tomentosum* at four sites were individually marked in 1980 and censused once a month between March 1981 and October 1981 (insect activity was low during the winter months so no data were collected). Each of the four sites had a windmill or water pump and a large tank for holding water. They were surrounded by fencing, and brush inside the fenced area had been periodically removed, leaving a few large trees, most of which were heavily infested with *P. tomentosum*. For each marked *P. tomentosum*, I recorded the diameter of the host (mesquite) tree, the distance of the tree from the nearest holding tank and the number of *P. tomentosum* on the tree. *P. tomentosum* plants were chosen to include a variety of host diameters, distances from water and densities of infestation (see Whittaker, 1982 for details). Plants were searched for *A. halesus* as thoroughly as possible. Because *A. halesus* larvae are very cryptic, some caterpillars were undoubtedly missed, especially on large, leafy mistletoe plants. For every *A. halesus* encountered, I recorded the stage of development (egg or larval instar number), the number of the host plant, and the part of the plant it was on (leaf, stem, or inflorescence). Leaves and stems were further divided into four size categories (Table 1). Data were analyzed to determine relative preference by *A. halesus* for *P. tomentosum* at different distances, densities and host diameters, and for different parts of the plant. More information on data collection and analysis is contained in Whittaker (1982).

RESULTS

Eggs are scattered over the host plant by the ovipositing female. As many as 22 were found on one plant, but they are not laid in clusters. Sometimes eggs are found on the branch of the mistletoe's host tree near the site of infection. Larval eclosion from the egg leaves an open-

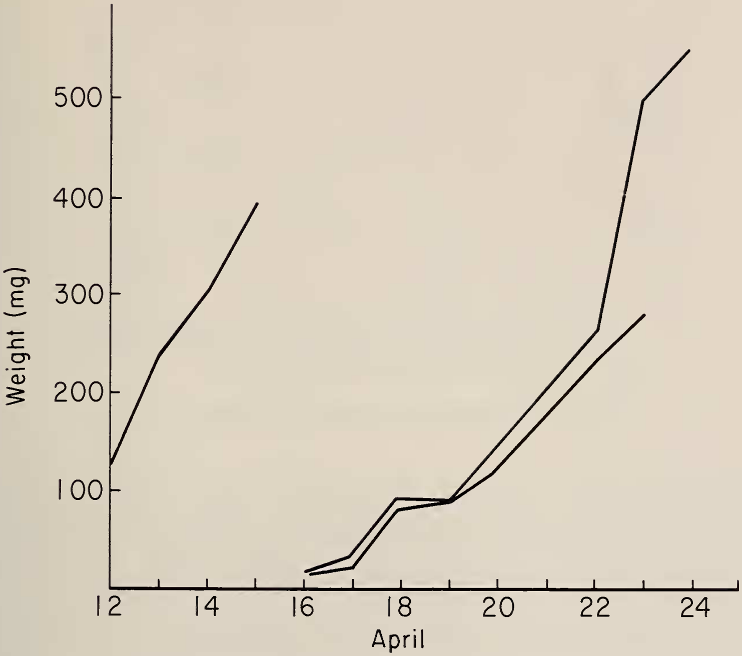

FIG. 1. Growth curves for three *A. halesus* larvae.

ing on the top of the egg and may be distinguished from parasitoid emergence, which leaves an opening on the side of the egg. The egg parasite is presumably a chalcidoid or proctotrupoid wasp but was not identified. The eggs have a hard outer surface and are easily noticeable. According to Haskins (1933), the duration of the egg stage is about seven days.

Larvae are green and darken with age. They are similar to a mistletoe leaf in color and texture, and extremely cryptic. Of the larvae collected at the Brackenridge site, one grew from 124 mg to 392 mg in four days before pupating, one grew from 11.7 mg to 281 mg in eight days and one increased from 15.7 mg to 553 mg in nine days (Fig. 1). Haskin's (1933) larvae spent about 20 days between hatching and pupation. Pupae are dark brown and are sometimes found at the base of trees on which mistletoe grows (Emmel & Emmel, 1973). The minimum duration of the pupal stage seems to be about 16 days (Haskin, 1933) (no records were kept of pupal eclosion by the three caterpillars from Brackenridge). Fig. 2 shows the phenology of *A. halesus* larvae at CWMA in 1981. Caterpillars are most common in late April but remained common through early June and were found during all censuses.

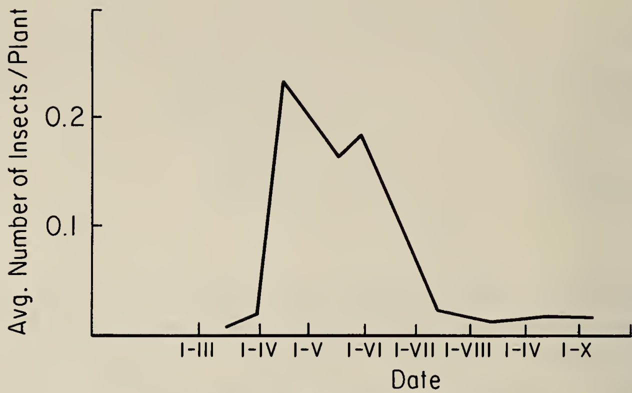

FIG. 2. Phenology of *A. halesus* at CWMA.

Fig. 3 shows the percent of observations of *A. halesus* larvae on different parts of the plant. Young (type 4) leaves were fed on most often, followed by fairly young (type 3) leaves, young (type 4) stems and fairly old (type 2) leaves. Early instar caterpillars fed on young leaves or rasped the surface of older leaves; late instars can chew through the older leaves. *A. halesus* larvae occasionally defoliated entire plants, leaving only woody (type 1 and type 2) stems remaining. Fig. 4 shows the observed number of larvae found on mistletoe plants growing at different densities divided by the expected number, based on a uniform distribution (Whittaker, 1982, p. 73). There were more *A. halesus* caterpillars than expected at low density infestations. The distribution of eggs showed a similar pattern; so, this distribution reflects preference by the ovipositing female and not differential mortality. *A. halesus* was also relatively more common on small diameter mesquite trees and far away from water tanks (Whittaker, 1982), both of which were correlated with low mistletoe density.

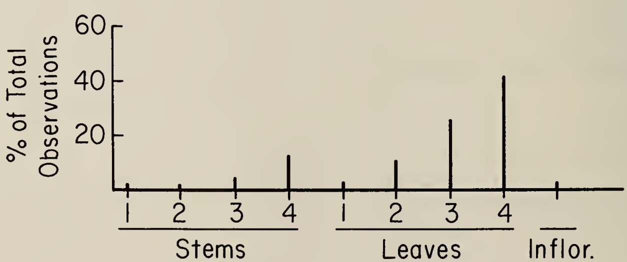

FIG. 3. Feeding preferences for different parts of the host plant.

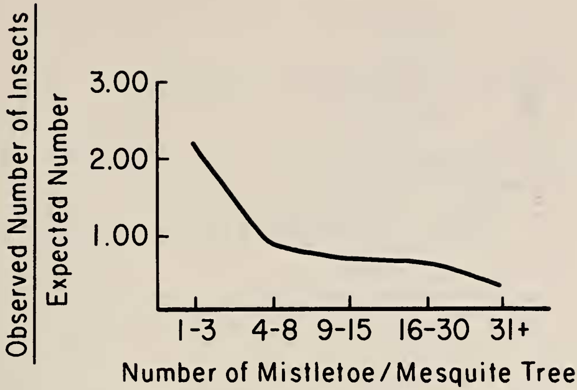

FIG. 4. Response of *A. halesus* to host plant density.

Fig. 5 shows the age structure of *A. halesus* found on censused plants. Eggs are probably over-represented, because they aren't cryptic like the larvae. Parasitism by an unidentified hymenopteran is a major source of egg mortality. First and second instar larvae weren't readily distinguishable, so they are grouped together. A braconid parasitoid (*Apanteles* sp.) emerged from many third instar larvae, leaving behind a cocoon underneath the dorsal integument of the caterpillar, and a large chalcidoid (*Metadontia amoena* Say) emerged from some pupae. Starvation following host plant defoliation was another source of mortality. Fig. 5 reflects the high incidence of mortality due to parasitism in the egg stage, third larval instar and pupae. Adults may be under-represented, because unlike the larvae, they don't spend all their time on the host plant and were only occasionally observed during oviposition.

DISCUSSION

Atsatt (1981) has hypothesized that selection for "enemy-free space" has been responsible for many of the radiations in host plant use within the Lycaenidae. Lycaenids have independently switched hosts to mistletoes (Loranthaceae, Viscaceae) several times. Many mistletoes are frequented by ants, which sometimes tend homopteran populations for nectar and protect lycaenid caterpillars from parasites and predators. *P. tomentosum* in Texas supports several species of host-restricted aphids and scale insects, all of which are tended by ants (Whittaker, 1982). No interactions between *A. halesus* larvae and any of the ant species were observed in the course of my study, and I suggest that the shift of *Atlides* onto mistletoe was a result of the nutritive qualities of the plant and not protection by ants. The remarkable cryptic col-

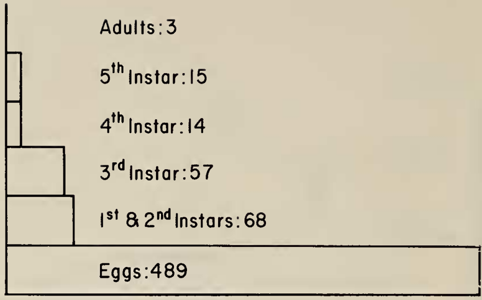

FIG. 5. Numbers of *A. halesus* of different ages.

oration of *A. halesus* larvae may offer protection against avian predators, but the high rates of parasitism indicate that it is not effective against hymenopterans. The noctuid moth *Emarginea* (*Cyathissa*) *percara* Morrison is preyed on heavily by hemipterans (*Largus cinctus* Herrich-Schaeffer, Largidae and *Podisus acutissimus* Stal, Pentatomidae) and attacked by at least one of the ant species which frequent *P. tomentosum*. *E. percara* feeds on the same parts of the mistletoe plant as *A. halesus* but is much more abundant in the Chaparral area and is more likely to be found on older, high density mistletoe infestations (Whittaker, 1982). *E. percara* defoliation is a major source of mortality for *P. tomentosum*. *A. halesus* also kills mistletoe plants and also threatens the resource base for the ants' homopteran herds, but its thick integument probably protects it from attack by both ants and hemipterans (Malicky, 1970). Many butterfly species have now been found to oviposit preferentially on isolated host plants (Courtney & Courtney, 1982). In the case of *A. halesus*, I believe it is a mechanism for reducing competition with the voracious and destructive *E. percara*, which is not a strong flier as an adult and probably has trouble reaching isolated mistletoe plants.

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